Microstructural damage of cancellous bone under uniaxial compression

Abstract

Microstructural damage of cancellous bone occurs as a result of daily functional loading conditions. However, bone has the ability to continuously repair the damaged regions with newly formed bone. The process is called bone remodeling and it plays an important role in the healing process of bone tissues. In this study, cancellous bone structure was analysed non-destructively by means of high resolution computed tomography (CT) with a spatial resolution of 0.5mm. Automated segmentation was carried out and a three dimensional reconstruction was made. Only a small portion of the bone can be reconstructed due to limitation on computing resources. A smoothing procedure was performed to remove unwanted sharp corners and the model was then meshed with tetrahedral elements to provide smooth surface representation. The completed finite element model was virtually loaded in compression and the von Mises effective stresses and strains. Region where failure occurred were marked. Results indicated that the struts mode of failure agreed well with those reported in the literature. The results also indicated that the stresses were localized in certain region of the bone, with some exceeding the strength of the bone simulating failure in these areas. This work provide an important step towards understanding the factors contributing to strut failure and establishing the bone remodeling phenomena in cancellous tissues.